SECTION 1005

AGGREGATE FOR CONCRETE

1005.1 Coarse Aggregate.

1005.1.1 All coarse aggregate for concrete shall consist of sound, durable rock, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances, exclusive of Items 5 and 6, shall not exceed 6.0 percent. For crushed stone, the percentage of wear shall not exceed 50 when tested in accordance with AASHTO T 96.

		Percent by Weight (Mass)
1.	Deleterious Rock	6.0
2.	Shale	1.0
3.	Chert in Limestone	4.0
4.	Other Foreign Material	0.5
5.	Material Passing No. 200 (75 µm) Sieve	
	a. Coarse Fraction, Limestone, Gradation A	1.5
	b. Fine Fraction, Limestone, Gradation A	2.5
	c. Limestone, Gradations B, D, & E	2.0
	d. Limestone, Gradation F	2.5
	e. Other Aggregates	1.0
6.	Thin or Elongated Pieces	5.0

The above requirements apply to each size or fraction of aggregate produced.

1005.1.1.1 Crushed stone shall be obtained from rock of uniform quality. Except as noted herein, rock tested from individual ledges for preliminary source approval shall meet the following criteria:

Log Angeles Abrasion, AASHTO T 96, percent loss, max	50
Absorption, AASHTO T 85, percent, max.:	
Portland Cement Concrete Pavement	2.0*
Portland Cement Concrete Masonry	3.5
Soundness, MoDOT Test Method T 14, percent loss, max.:	
Portland Cement Concrete Pavement	16.0
Portland Cement Concrete Masonry	18.0

* If an individual ledge or ledges in a production face constitutes 15 percent or less of the total thickness of the production face height being used to produce the final product, the absorption for that individual ledge or ledges may exceed the maximum limit specified by 0.5 percentage points.

1005.1.1.2 Crushed stone for portland cement concrete pavement, base and approach slabs for bridges, from sources required to conform to Gradation F, shall be from individual ledges having preliminary approval under the following criteria:

Log Angeles Abrasion, AASHTO T 96, percent loss, max	50
Absorption, AASHTO T 85, percent, max.	1.5
Soundness, MoDOT Test Method T 14, percent loss, max.	10.0
Bulk Specific Gravity, AASHTO T 85, min.	2.58

1005.1.1.3 Gravel shall be washed and shall meet the following for preliminary and final approval:

Log Angeles Abrasion, AASHTO T 96, percent loss, max	45
Absorption, AASHTO T 85, percent, max.	4.5
Soundness, MoDOT Test Method T 14, percent loss, max.	18.0

1005.1.1.4 The engineer reserves the right to also use additional test methods such as ASTM C 586, AASHTO T 161, AASHTO T 104 or other appropriate tests to measure the soundness and durability of aggregates for use in concrete when deemed necessary.

1005.1.2 Coarse aggregate for concrete pavement or base course shall be crushed stone or porphyry and may be furnished, handled and batched in two separate sizes or fractions or in one size or fraction, as herein specified.

1005.1.2.1 If coarse aggregate for concrete pavement or base is furnished, handled and batched in two separate sizes or fractions, one fraction shall consist of material retained on the 3/4-inch (19.0 mm) sieve, and the other fraction shall consist of material passing the 3/4-inch (19.0 mm) sieve. A tolerance not to exceed 15 percent may be permitted on the 3/4-inch (19.0 mm) sieve for each fraction. The two fractions will be combined in a ratio as near as possible to the proportions in which the two fractions are furnished by the contractor to make a uniformly well-graded coarse aggregate graded within the following limits:

Gradation A	**Percent by Weight (Mass)**
Passing 2-inch (50 mm) sieve	100
Passing 1 1/2-inch (37.5 mm) sieve	95-100
Passing 3/4-inch (19.0 mm) sieve	35-70
Passing 3/8-inch (9.5 mm) sieve	10-30
Passing No. 4 (4.75 mm) sieve	0-5

Coarse aggregate may be divided into more than two fractions if approved by the engineer.

1005.1.2.2 If crushed flint is used as coarse aggregate, the crushed flint shall meet the above requirements, and in addition 100 percent shall pass the 1 1/2-inch (37.5 mm) sieve.

1005.1.2.3 The contractor shall be responsible for maintaining the proper balance in the quantities of each fraction and for securing the final quantities of each fraction in such proportions as to minimize wastage.

1005.1.2.4 If coarse aggregate for concrete pavement or base is furnished, handled and batched in one size or fraction, the aggregate shall be graded to meet Gradation B, as follows or Gradation D, Sec 1005.1.3 except when Gradation F is required as defined in Sec 1005.1.2.5.

Gradation B	Percent by Weight (Mass)
Passing 1 1/2-inch (37.5 mm) sieve	100
Passing 1-inch (25.0 mm) sieve	95-100
Passing 1/2-inch (12.5 mm) sieve	25-60
Passing No. 4 (4.75 mm) sieve	0-8

1005.1.2.5 Coarse aggregate for portland cement concrete pavement, base and approach slabs for bridges which is not produced from the Burlington, Keokuk, Cedar Valley (formerly Callaway) or Warsaw limestone formations which is obtained from sources in the following areas shall be graded to conform to Gradation F.

(a) State of Kansas, Iowa and Nebraska.

(b) Counties of Missouri - Adair, Andrew, Atchison, Bates, Benton, Buchanan, Caldwell, Carroll, Cass, Cedar, Chariton, Clay, Clinton, Daviess, DeKalb, Gentry, Grundy, Harrison, Henry, Holt, Jackson, Johnson, Lafayette, Linn, Livingston, Mercer, Macon, Nodaway, Pettis, Platte, Putnam, Randolph, Ray, St. Clair, Saline, Schuyler, Sullivan, Vernon and Worth.

Gradation F	Percent by Weight (Mass)
Passing 1/2-inch (12.5 mm) sieve	100
Passing 3/8-inch (9.5 mm) sieve	85-100
Passing No. 4 (4.75 mm) sieve	10-30
Passing No. 8 (2.36 mm) sieve	0-10
Passing No. 16 (1.18 mm) sieve	0-5

1005.1.3 Coarse aggregate for concrete for structures, except as specified in Sec 1005.1.4, may be gravel or crushed stone. Coarse aggregate for Class B, B-1, B-2 or Seal concrete shall meet the requirements of either Gradation D or E. Coarse aggregate for Class A-1 concrete shall meet the requirements of Gradation E.

Gradation D	Percent by Weight (Mass)
Passing 1-inch (25.0 mm) sieve	100
Passing 3/4-inch (19.0 mm) sieve	90-100
Passing 3/8-inch (9.5 mm) sieve	15-45
Passing No. 4 (4.75 mm) sieve	0-8

Gradation E	Percent by Weight (Mass)
Passing 3/4-inch (19.0 mm) sieve	100
Passing 1/2-inch (12.5 mm) sieve	80-100
Passing 3/8-inch (9.5 mm) sieve	40-70
Passing No. 4 (4.75 mm) sieve	0-10
Passing No. 8 (2.36 mm) sieve	0-4

1005.1.4 Coarse aggregate for ornamental concrete shall be crushed stone meeting the requirements of Sec 1005.1.3, Gradation E. However, the use of coarse aggregate containing more than 2 percent chert will not be permitted.

1005.2 Fine Aggregate.

1005.2.1 Fine aggregate for concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature or manufactured from an approved limestone or dolomite source as defined in Sec 1005.1. By specific approval of the engineer, chat sand produced from flint chat in the Joplin area or fines manufactured from igneous rock or chert gravel may be used. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating of injurious material. The percentage of deleterious substances shall not exceed the following values:

	Percent by Weight (Mass)
Clay Lumps and Shale	0.25
Coal and Lignite	0.25
Total Lightweight (low mass density) Particles, Including Coal and Lignite	0.50
Material Passing No. 200 (75 µm) Sieve	
a. Natural Sand	2.0
b. Manufactured Sand	4.0
Other Deleterious Substances	0.10

Lightweight (Low mass density) sand particles are not considered deleterious lightweight (low mass density) particles. The total lightweight (low mass density) particle requirement shall not apply to angular chert sand or manufactured sand.

1005.2.2 Fine aggregate subjected to the mortar strength test shall produce a mortar having a compressive strength at the age of 7 days of at least 90 percent of that developed at the same age by mortar of the same proportions and consistency made of the same cement and Standard Ottawa sand. Tests shall be made in accordance with AASHTO T 106. Cement used in the tests shall be Type I meeting the requirements of Sec 1019.

1005.2.2.1 Fine aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard will be rejected unless compliance with the mortar strength test specified in Sec 1005.2.2 is met.

1005.2.3 Fine aggregate for ornamental concrete shall be free from coal and lignite material when tested in accordance with AASHTO T 113.

1005.2.4 Gradation.

1005.2.4.1 All fine aggregate shall meet the following gradation requirements:

	Percent by Weight (Mass)
Passing 3/8-inch (9.5 mm) sieve	100
Passing No. 4 (4.75 mm) sieve	95-100
Passing No. 20 (850 µm) sieve	40-75
Passing No. 50 (300 µm) sieve	5-30
Passing No. 100 (150 µm) sieve	0-10

1005.3 Lightweight (Low Mass Density) Aggregates.

1005.3.1 Lightweight (Low mass density) aggregates shall be prepared by expanding, calcining or sintering argillaceous material such as clay, shales and slates.

1005.3.2 Grading. The grading shall be uniform and conform to the requirements given in Table I.

1005.3.3 Unit Weight (Mass). The unit weight (mass) of lightweight (low mass density) aggregates shall not exceed the following:

	Dry, Loose Weight (Mass), Max, lb per cu ft (kg/m^3)
Fine Aggregate	70 (1120)
Coarse Aggregate	55 (880)

1005.3.3.1 Uniformity of Weight (Mass). If the unit weight (mass) of any shipment of lightweight (low mass density) aggregate when tested in accordance with AASHTO T 19 is found to vary by more than 10 percent from that of the sample submitted for source approval, the aggregate in the shipment may be rejected.

1005.3.4 Soundness. When tested in accordance with AASHTO T 104, the loss of lightweight (low mass density) fine or coarse aggregate in 5 cycles of the accelerated soundness test shall not exceed 8 percent if sodium sulfate is used or 10 percent if magnesium sulfate is used.

1005.3.5 Drying Shrinkage. The drying shrinkage of concrete specimens prepared and tested in accordance with Section 9.1.4 of AASHTO M 195, shall not exceed 0.07 percent.

1005.3.6 Sampling. Samples of fine and coarse aggregate shall be furnished by the contractor for source approval. Other samples shall be taken from shipments at intervals specified by the engineer.

TABLE I
Grading Requirements for Lightweight Aggregate

ENGLISH

Grade	Size	Percent Passing Sieve Sizes									
		1 1/2”	**1”**	**3/4”**	**1/2”**	**3/8”**	**No. 4**	**No. 8**	**No. 16**	**No. 50**	**No. 100**
	Fine Aggregate No. 4 to 0	….	….	….	….	100	85-100	….	40-80	10-35	5-20
	Coarse Aggregate										
1	1” to 1/2”	100	90-100	20-55	0-10	0-5	….	….	….	….	….
2	1” to No. 4	100	95-100	….	25-60	….	0-10	0-5	….	….	….
3	3/4” to No. 4	….	100	90-100	….	20-55	0-10	0-5	….	….	….
4	1/2” to No. 4	….	….	100	90-100	40-70	0-15	0-5	….	….	….
5	3/8” to No. 8	….	….	….	100	85-100	10-30	0-10	0-5	….	….

METRIC

Grade	Size	Percent Passing Sieve Sizes									
		37.5 mm	**25.0 mm**	**19.0 mm**	**12.5 mm**	**9.5 mm**	**4.75 mm**	**2.36 mm**	**1.18 mm**	**300 µm**	**150 µm**
	Fine Aggregate 4.75 to 0	….	….	….	….	100	85-100	….	40-80	10-35	5-20
	Coarse Aggregate										
1	25.0 to 12.5	100	90-100	20-55	0-10	0-5	….	….	….	….	….
2	25.0 to 4.75	100	95-100	….	25-60	….	0-10	0-5	….	….	….
3	19.0 to 4.75	….	100	90-100	….	20-55	0-10	0-5	….	….	….
4	12.5 to 4.75	….	….	100	90-100	40-70	0-15	0-5	….	….	….
5	9.5 to 2.36	….	….	….	100	85-100	10-30	0-10	0-5	….	….